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The impact of ice uptake of nitric acid on atmospheric chemistry

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Abstract. The potential impact of the uptake of HNO_3 on ice on the distribution of NO_y species, ozone and OH has been assessed using the global scale chemistry-transport model MATCH-MPIC. Assuming equilibrium uptake according to dissociative Langmuir theory results in significant reductions of gas phase HNO_3. Comparison to a large set of observations provides support that significant uptake of HNO_3 on ice is occurring, but the degree of the uptake cannot be inferred from this comparison alone. Sensitivity simulations show that the uncertainties in the total amount of ice formation in the atmosphere and the actual expression of the settling velocity of ice particles only result in small changes in our results. The largest uncertainty is likely to be linked to the actual theory describing the uptake process and the value of the initial uptake coefficient. The inclusion of non-methane hydrocarbon chemistry partially compensates for the absence of HNO_3 uptake on ice when this is neglected in the model. The calculated overall effect on upper tropospheric ozone concentrations and the tropospheric methane lifetime are moderate to low. These results support a shift in the motivation for future experimental and theoretical studies of HNO_3-ice interaction towards the role of HNO_3 in hydrometeor surface physics.

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